TECHNICAL EFFICIENCY IN TRANSPORT MANUFACTURING FIRMS: EVIDENCE FROM MALAYSIA

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ABSTRACT

This study aims to identify the level of technical efficiency and the determinants of technical inefficiency for transport manufacturing firms in Malaysia for 2010 using cross-sectional data of 130 firms acquired from the Department of Statistics (DOS). Based on the stochastic frontier analysis (SFA) approach, the results of the study reveal that the average level of technical efficiency is moderate. The estimated result identifies the important determinants of technical inefficiency which are due to employee wage rates as well as the cost of information and communication technology. The fundamental implications of this study are that transport manufacturing firms need to boost motivation among employees and strengthen the network of the production market via wage increment and communication cost.

Keywords: technical efficiency, technical inefficiency, firms, transportation, stochastic frontier analysis

INTRODUCTION

Based on Debreu (1951) and Farrell (1957), technical efficiency refers to the one rejected by the reduction of the maximum proportion that still allows production to give a total output. In other words, the value of one indicates the level of technical efficiency and a score of less than one indicates the level of technical inefficiency (Porcelli, 2009).

Meanwhile, Kumbhakar and Lovell (2003) posited that technical efficiency defined as the capacity of a firm in producing a maximum output from a given set of inputs or producing the maximum output from the minimum quantity of inputs. The determinants of technical efficiency and their measurements are important in the theory of production. Technical efficiency is vital in determining the efficiency level of a firm or an industry as well as contributes to the economic growth of a country. Under the 10th Malaysia Plan, the issue of efficiencies has been addressed to create a more competitive economy in achieving developed nation status by 2020.

In general, efficiency in transportation manufacturing firms contribute to the growth of productivity. Transportation manufacturing firm is one of the important sectors in the industry and considered as a production model for the movement of people and goods into shaping economic growth and job creation that supports public policies related to energy consumption. The firm also contributes to transport chain efficiency to reduce operational costs, improve delivery performance, increase customer satisfaction, and enable them to grow more competitive in terms of cost, quality, delivery, and flexibility (Perbadanan Produktiviti Malaysia, 2013/2014).

During the period between 2009 to 2013, the investment in the transport manufacturing industry was between RM700 million to RM5 billion in 2012. Besides that, the total export earnings were RM5.3 billion, whereas the total import earnings were RM21.7 billion. Moreover, the export value for the automotive manufacturing subsector amounted to RM4.3 billion and the export of the passenger vehicles was RM700 million. In 2013, Malaysia recorded its total sales and vehicles' production at the third place after Thailand and Indonesia. Malaysia was also the third largest automotive market after Indonesia and Thailand in the segment of passenger cars in ASEAN (MITI, 2013). The sales increase is driven by the annual economic growth of 4% to 5%, the introduction of the competitive pricing model, competitive price, and increased purchasing power of consumers. Meanwhile, the overall automotive sales increased from 536,905 units in 2009 to 652,120 units in 2013.

For 2013, transport manufacturing firms have contributed 3.6% to the gross domestic product (GDP) and was an important component in the nation's growth (Perbadanan Produktiviti Malaysia, 2013/2014). In addition, the country has set a goal of making transport manufacturing industry as one of the National Key Economic Areas (NKEA) which enables the industry to not just be competitive locally but also at international level.

Eventhough the contribution of the transport manufacturing industry is increasing in Malaysia, the trade openness has made the industry to face more intense competition. Besides that, the industry is experiencing fluctuations which cause profit margins earned from production activities to become smaller (MITI, 2014). In this context, transport manufacturing firms must be more productive to achieve high productivity in ensuring towards the savings of production costs by increasing the efficiency of the firms.

Most studies of technical efficiency only focus on the level of technical efficiency. There is limited study on the determinants of technical efficiency. In fact, the most relevant on the level of technical efficiency analysis does not really use cross-sectional data at the firm or micro level. As a result, the level of technical efficiency obtained is not significant. Battese and Coelli (1995) pointed out that by considering the factors of technical inefficiencies, data at firm level can play an important role to obtain an accurate value of technical efficiency. In addition, this micro data is also more efficient compared to the time-series data as the researcher has the advantage of solving some of the problems associated with the estimates and the bias aggregation to aggregated industry data (Md Isa, 2005).

New empirical findings can be generated when using data at the firm level taking into account, factors that may decrease the efficiency of improvement efforts. Tingley, Pascoe, and Coglan (2005) support this by stating that estimations using firms' data as well as individuals are considered a more advanced analysis of the factors affecting the level of budgeting which can be studied. Thus, studies that use data at the firm level by taking into account the factors of technical incompetence will bring more significant and appropriate results.

Based on the research problem, the main objective of the study is to examine the level of technical efficiency of transport manufacturing firms in Malaysia considering all six subsectors. Besides that, this study analyses the determinants of technical inefficiency in transport manufacturing firms.

LITERATURE REVIEW

This study involved a cross-sectional data at the firm level or micro level. This type of data is becoming increasingly popular among researchers. More efficient budgeting can be generated through microdata relative to the time series data in aggregate form. In addition, the problem of heterogeneity and bias which occurs to aggregate macro data can be overcome. This type of data also highlight each firm's distinctiveness, such as capital intensity and use of technology, or is expected to be heterogeneous. At the same time, the data at firm level can also identify the determinants of technical efficiency.

However, there are limited studies in Malaysia, particularly on firms, that use data to measure the level of technical efficiency. Several empirical studies in other countries (Pitt & Lee, 1981; Lieberman & Dhawan 2005; Radam, Abu, & Abdullah, 2008) used firms' data by using the firms' data on budget, and then determine the efficiency of variables of specific firms (including management experience, characteristics ownership, etc.) in an effort to identify some of the factors contributing to the efficiency differences between firms within the industry.

There are other studies that investigate the determinants of technical efficiency by positing that the capital-labour ratio can reduce engineering inefficiencies, thus increase the efficiency of the technique (Stevens & Kneller, 2003; Minh, Long, & Thang, 2007). Bertrand (2013) stated that a composition in the use of capital has a positive impact on efficiency when production levels increased in the event of high usage of machines in the production process. While Barrett and O'Connell (2001) found that the effects of exercise (either in general or specific) such as workplace training (on-the-job training) has a direct relation to the increase in productivity. This is supported by Almeida and Carneiro (2009), and Essmui, Madeline, Faridah, and Shamshubarida (2013).

Petrakis and Stamatakis (2002) posited that the benefits of higher education and secondary education is much higher in developing countries than in developed countries. Most of the other studies also showed increased levels of employee education can increase firms' production (Andersson, Holmlund, & Lindh, 2002). The number of years of schooling or education could be one of the important roles in identifying the performance of the firm, including output, profits, and productivity (Idiong, 2007; Ajibefun, 2008; Murthy, Sudha, Hedge, & Dakshinamoorthy, 2009).

Batra and Tan (2003) found that the level of technical efficiency increases with the enlargement of firm's size. However, there are also some small firms that operate more efficiently than the larger size. Despite an improvement in the level

of technical efficiency with the firm size, this situation has undermined the policy of small and medium industries (Mini and Rodriguez, 2000). Other studies such as by Sinani, Jones, and Mygind (2008); Amornkitvikai, Harvie, and Charoenrat (2014); and Charoenrat, Harvie, and Amornkitvikai (2013) showed that the size of the firm can affect the level of technical efficiency of firms. Badunenko, Fritsch, and Stephan (2008) contradicted with others and found that the firm size does not affect the efficiency of such techniques.

In addition, a study in China by Huang, Hallam, Orazem, and Paterno (1998) showed that the efficiency and productivity changes are more influenced by wage rates compared with the human capital factor. However, Mazumder and Adhikary (2010) found that spending on the welfare of employees, including increasing the rate of wages, is not an important factor in determining the level of technical inefficiency in a firm.

In addition, some previous studies show that ICT cost in developed countries is positively significant, but not in developing countries. Meng and Li (2002) stated that there is a big gap between China and developed countries in the development of the ICT industry. Chowdhury (2006) found that excessive ICT investment and incompatibility between human capital and technology will result in negative impact on efficiency and productivity. There is a possibility that the ICT capital investment needs some time to have an impact on productivity. Although, theoretically, the impact of ICT is positive over time, but some studies have found the results obtained are varied (Hempell, 2005; Giuri, Torrisi, & Zinovyeva, 2008).

In Malaysia, the efficiency of transport engineering manufacturing firms received less attention from researchers compared to other industries. An example of other countries that studied the transportation manufacturing industry includes Alvarez and Crespi (2003), and Chu and Kalirajan (2011) in Chile and Vietnam, which posited that the efficiency of transport manufacturing sector has a significant contribution to the manufacturing industry. This is similar to a study conducted by Karunaratne (2012) in Australia. In the US, Petrin, White, and Reiter (2011) found that growth will slow down in manufacturing sector despite the finding that the level of technical efficiency of transport as a whole provides a significant contribution to economic growth in the country.

Amdun (2007), Rosli and Kari (2008), and Khalifah (2013) only compared the performance of manufacturing sector focusing on local transportation firms with foreign firms. The achievement of technical efficiency of foreign firms is much higher. The studies also found that the average technical efficiency among the ownership groups did not indicate significant differences. Factors such as skilled

labour, skills training, subsector size, and high quality of the workforce are driven towards improving technical efficiency.

However, the study did not use firms' data which takes into account more precise and significant factors that can lead to inefficiencies techniques. This contradicts with studies that concentrate on transport manufacturing firm which take into account the factors of inefficiency and the use of firms' data.

THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

Stochastic Frontier Analysis

To yield the technical efficiency value of a firm, stochastic frontier analysis (SFA) was used by Aigner, Lovell, and Schmidt (1977), and Meeusen and van den Broeck (1977), followed by Battese and Coelli (1995). Efficiency at the frontier level can be measured by estimating manufacturing SFA model derived from sample performance or the top-performing firm which can be adopted to mirror the technological advancement being used by the whole sample or industry. Meanwhile, samples that performed below the frontier are considered inefficient, hence there is a need to increase productivity and advancement in technology or managerial and quality such as educational level (Jaafar, Mustapha, & Talib, 2004). Cullinane, Wang, Song, and Ji (2006) insist that the SFA approach can analyse structure, examine determinants and production performance.

SFA is also widely used in measuring technical efficiency, allocative efficiency, and economic efficiency for the transport industry. Oum and Yu (1998), Inglada, Coto-Millan, and Rodriguez-Alvarez (1999), Sanchez and Villarroya (2000), and Vitaliano (2002) used this technique to estimate technical efficiency of this sector. Following Battese and Coelli (1995), the stochastic production function can be written as follows:

$$Y_i = X_i \beta + (v_i - u_i) \tag{1}$$

In equation (1), i ($i = 1, 2, ..., n$) represents the number of input respectively. The output variable, Y_i, represents the output of the i-th firm; the explanatory variable, X_i, represents a vector of K inputs; β represents a vector of K unknown parameters; and v_i is a random variable which is assumed to be $N(\mu, \sigma_v^2)$ as well as independent from u_i, the specific error term which is attributed as the inefficiency effect in the model. Non-negative truncation of the distribution of u_i is assumed to be $N(\mu, \sigma_v^2)$. The variance parameter of the model can be parameterised as $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and

$\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$ where σ^2 is the variance of output (Battese & Corra, 1977). Here, γ lies between 0 and 1. A value of γ from zero indicates the deviations from the frontier is entirely due to noise and while the value is one, it indicates that all the deviations are due to technical inefficiency (Coelli, Rao, O'Donnell, & Battese, 2005; Arunsawadiwong, 2007; Tran, Grafton, & Kompas, 2008). The model incorporates a simplified specification inefficiencies following Battese and Coelli (1992) as follows:

$$u_i = exp[-\eta(t-T)]u_i \qquad (2)$$

Here, u_i is the technical inefficiency effect in the model, the unknown parameter η needs estimation that determines whether inefficiencies are time varying or not. Positive, zero and negative values of η correspond to declining, constant, and increasing technical inefficiency overtime when η is negative.

Following Battese and Coelli (1995), the inefficiency distribution parameter, which can be estimated from the maximum likelihood estimation (MLE) model, can be written as:

$$u_i = \sigma_i W_i + z_i \qquad (3)$$

Where, u_i is technical inefficiency, W represents the controllable variables that can affect technical inefficiency and z represents the uncontrollable variable. According to Coelli et al. (2005), the technical efficiency of the i-th firm is as follows:

$$TE_i = E[exp(-u_i)] \qquad (4)$$

The range of TE is 0 to 1. TE = 1 implies that the firm is producing on its production frontier and is said to be technically efficient. Hence, $(1 - TE)$ represents the gap between actual production and optimal attainable production that can be achieved by moving the firm towards the frontier through readjusting inputs (Chavas & Aliber, 1993).

Model Specification

The two model specifications normally adopted in stochastic frontier studies are presented in Cobb-Douglas function (5) and translog function (5) as follows:

$$\ln Y_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + (v_i - u_i) \qquad (5)$$

$$\ln Y_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \tfrac{1}{2}\beta_3 (\ln K_i)^2 + \tfrac{1}{2}\beta_4 (\ln L_i)^2$$
$$+ \beta_5 (\ln K_i \times \ln L_i) + (v_i - u_i) \tag{6}$$

where Y_i is the log for the amount of nominal output of the *i*-th firm, K is the log for the amount of nominal asset of the *i*-th firm. Whereas, L is the log for the amount of labour for the *i*-th firm and v_i is the random variable or random effect, identical and normally distributed (independent and identically distributed, IID), normally distributed with $[N(0, \sigma_v^2)]$. Meanwhile, u_i is the non-negative random variable that can be assumed to explain inefficiency in production which is normally assumed to be IID as truncated at zero for distribution $[N(m_i, \sigma_u^2)]$.

The variables incorporated within the technical inefficiency component of the SFA model are as follows:

$$u_i = \delta_0 + \delta_1 \ln K/L_i + \delta_2 \ln TRE_i + \delta_3 \ln SEC/L_i + \delta_4 \ln TIER/L_i$$
$$+ \delta_5 \ln W/L_i + \delta_6 \ln ICT_i + \delta_7 \ln DFSME_i \tag{7}$$

where u_i is technical inefficiency, K/L_i represents the total capital ratio divided by the number of employees for the *i*-th firm, TRE represents the amount of employee training expenses for the *i*-th firm, SEC/L_i represents the ratio of employees trained at diploma level and STPM or equivalent for the *i*-th firm, $TIER/L_i$ represents the ratio of employees trained at a higher level including advanced degree or equivalent for the *i*-th firm, W/L_i is the wage rate for the *i*-th firm, ICT_i is the communication cost for the *i*-th firm, and DFSME is the dummy for the *i*-th firm with small firms size represent 1 and others are considered 0.

Hypothesis-testing based on likelihood ratio will be conducted to choose the type of function and to determine the existence of inefficiency. The first test is choosing the type of function either Cobb-Douglas production model or translog through maximum likelihood estimation. The second test is to find out whether the effects of inefficiency exist. Various hypothesis-testing of the parameters in the frontier production function can be performed using the likelihood ratio (LR) test statistic, λ, given by:

$$\lambda = -2 \{\ln[\lambda(H_0) / \lambda(H_1)]\} = -2 \{\ln[\lambda(H_0)] - \ln[\lambda(H_1)]\} \tag{8}$$

where $\lambda(H_0)$ and $\lambda(H_1)$ denote the value of the log likelihood function under the null and alternative hypothesis respectively (Coelli, Rao, & Battese, 1998). The necessary tests with respect to other estimated parameters of the variables will be performed as in the case of the normal analysis. FRONTIER 4.1 programme (Coelli, 1996) was employed to analyse MLE in order to get the technical efficiency (TE) value.

Source of Data and Variable Identification

The study used data collected at the firm level of the manufacturing industries which is controlled by the Department of Statistics (DOS). This data includes data in 2010 and in which the firms can be categorised into six subsectors on the 3-digit level by the Malaysian Standard Industrial Classification (MSIC 2008).

The data consists of manufacturing of motor vehicles, passenger cars, and commercial vehicles; manufacturing of template (coachwork) for motor vehicles and manufacturing of trailers and semi-trailers; manufacturing of parts and accessories for motor vehicles; ship and boat building, shipbuilding and floating structures and construction of leisure boats and sports; construction of air and spacecraft and related machinery; transportation equipment manufacturing activities not elsewhere classified; and manufacturing of motorcycles and bicycles and invalid carriages.

The study used data at the firm level so that a more significant and accurate result can be obtained. TE estimation using data as an individual firm is better because further analysis of the determinants affecting the level of TE can be studied. In addition, the microdata is also more effective than the time-series data as the researcher has the advantage to solve some of the problems associated with the estimation and aggregation on the bias of aggregate industry data (Md Isa, 2005).

RESULTS AND DISCUSSION

Hypothesis Test

The MLE result for the parameter in the SFA model through the Cobb-Douglas production model and translog as defined by equations (5) and (6) yielded using the FRONTIER 4.1 programme and the result is presented in Table 1.

Table 1
Generalised log-likelihood tests of hypotheses

	$H_0 : \beta_{ij} = 0$	$H_0 : \gamma = 0$
LR statistic (Chi-Square)	15.324**	50.001**
Critical value	7.815	16.274
Decision	Reject H_0	Reject H_0

** significant at 5% levels

The first test is to choose the type of production function, whereby the null hypothesis represents Cobb-Douglas production model. LR statistical value to test null hypothesis, H_0: $_{ij} = 0$, being counted as $LR = -2 = 15.324$. This value was compared to the critical value for distribution (at the highest 5% level), 7.815. Based on the comparison, Cobb-Douglas production model was rejected whereas translog production model was selected as it was deemed suitable to represent the data under the study.

The second hypothesis-testing is to determine that there is no effect of technical inefficiency (H_0: $\gamma = 0$) in the transport manufacturing firms. The result of the hypothesis-testing shows statistical value at 50.001 was greater than the critical value at 5% significance level; 16.274 which indicates the existence of technical inefficiency that affects transport manufacturing firms in Malaysia.

This test supports a certainty of inefficient firms' existence which enables further testing to be done. The testing performed used data obtained from the firms to identify the factors affecting engineering firms inefficiency. This analysis is in contrast with most previous studies, such as Khalifah (2013), Ismail and Jajri (2008), Rosli and Kari (2008), and Amdun (2007) which have ignored the determinants of technical inefficiency.

Descriptive Statistics

This study was conducted on 130 transport manufacturing firms in Malaysia in 2010. Table 2 displays descriptive statistics of the variables used for SFA estimation. The table exhibits the overall average amount of output produced by the transport manufacturing firms which was RM310 million with a minimum of RM7 million to a maximum of RM8 billion. Capital is a major expense for transport manufacturing firms with the average spending of RM64 million between RM70,000 to RM2 billion. In addition, the average number of employees employed was 510 people ranging from 16 to 8,198 people. The study also found that the ratio between capital and labour in the transport manufacturing firms ranged from RM124 to RM165,000 with an average of RM120,000. Furthermore, the transport manufacturing firms had spent an average of RM301 million, with expenditures ranging from RM0 to RM11 million, for the cost of employee training. Besides that, the average ratio of employees with the highest qualification, including advanced degree or equivalent, was 0.083 ranging from 0.004 to 1.000. As for the ratio of employees having a diploma and Malaysian Higher School Certificate or equivalent, it shows an average range of 0.164, ranging from 0.000 to 0.868. Furthermore, the firms' employees average wage in the year was RM27,000 ranging between RM7,000 to RM91,000. The firms had also spent an average of

RM400,000 for ICT with minimum spending of RM2,000 and maximum spending of RM9 million. Meanwhile, SME dummy showed that 60% of the firms involved in this study were small-sized and medium-sized firms. Standard deviation showed that the variance fell over the entire sample. The result also showed that there was too much dispersion in the transport manufacturing firms.

Table 2
Descriptive statistics of the variables

Variable		Mean	Minimum	Maximum	Standard deviation
Y	(RM)	310,523	7,222	8,056,806	1068269.655
K	(RM)	64,984	70	2,075,002	218390.620
L		510	16	8,198	994.617
K/L	(RM)	120.983	1.241	1648.844	200.300
TRE	(RM)	301	0	11,403	1201.330
TIER	Ratio	0.083	0.004	1.000	0.104
SEC	Ratio	0.164	0.000	0.868	0.148
W	(RM)	27.042	7.800	91.660	12.515
ICT	(RM)	400	2	9,013	1053.222
DFSME	Number	0.400	0	1	0.492

Notes: Y = output; K = capital; L = labour; K/L = ratio of capital labour; TRE = employee training expenses; SEC/L = ratio of employees trained at diploma level and Malaysian Higher School Certificate or equivalent; TIER/L = ratio of employees trained at a higher level including advanced degree or equivalent; W/L = wage rate; ICT = communication cost; DFSME = dummy for small medium firms size

Technical Efficiency Analysis

Table 3 displays the frequency and the index distribution of technical efficiency in the transport manufacturing subsector in Malaysia in 2010. This finding describes the contribution of technical efficiency of a firm in transport manufacturing subsector. The findings revealed that the subsector 3 – manufacturing of parts and accessories for motor vehicles – contributed to the most number of firms that participated in this study, i.e. 63 firms or 48.47%. Subsector 4 – ship and boat building, shipbuilding and floating structures, and construction of leisure boats and sports – consists of 26 firms or 20.02%.

If scrutinised closely, the frequency and index distribution of technical efficiency between 0.81 to 0.90 were the highest range of the overall subsectors, i.e. 23.08%, followed by index distribution of technical efficiency between 0.71 to 0.80 which was 16.93%. These results were driven by higher demand due to the rapid economic growth of between 4% to 5% per annum and increase in purchasing power. Thus,

firms have increased the level of efficiency through the use of modern technology and improving the skills of employees (MITI, 2013).

Table 3
Frequency and index distribution of technical efficiency based on subsectors of transport manufacturing firms in Malaysia

	Technical Efficiency Range (subsector)					
Per cent	1	2	3	4	5	6
≤ 0.20	0.77	0.77	3.08	4.62	0.00	0.00
0.21–0.30	0.00	0.77	2.31	2.31	1.54	1.54
0.31–0.40	0.00	0.00	3.08	1.54	1.54	0.77
0.41–0.50	0.00	0.00	5.38	3.08	0.00	0.77
0.51–0.60	0.77	0.77	6.15	0.00	0.77	0.00
0.61–0.70	1.54	0.77	4.62	2.31	0.00	1.54
0.71–0.80	0.00	0.77	13.08	1.54	0.00	1.54
0.81–0.90	3.85	0.00	9.23	2.31	0.77	6.92
0.91–100	0.77	0.00	1.54	2.31	0.00	2.31
Mean	7.70	3.85	48.47	20.02	4.62	15.39

Notes: 1 = manufacturing of motor vehicles, manufacturing of passenger cars and commercial vehicles
2 = manufacturing of template (coachwork) for motor vehicles and manufacturing of trailers and semi-trailers
3 = manufacturing of parts and accessories for motor vehicles
4 = ship and boat building, shipbuilding and floating structures, and construction of leisure boats and sports
5 = construction of air and spacecraft and related machinery
6 = transportation equipment manufacturing activities not elsewhere classified, manufacturing of motorcycles and bicycles and invalid carriages

Determinants of Technical Inefficiency

Table 4 illustrates the results of parameter estimator of stochastic frontier production model 2010 using FRONTIER 4.1, which was developed by Coelli (1996). The results of the analysis show that the most input parameter estimator in transport manufacturing industry is significant at 1% significant level. Each input can be explained by the significant output. When there was an increase of 1% in the capital, the total output increased by 0.700%. Similarly, when there was an increase of 1% in the amount of labour, the total output increased by 0.116%.

The gamma value based on the analysis conducted is 0.322. The significant technical inefficiencies had a significant impact on the level and production change of transport manufacturing firms in this study. Apart from that, parameter sigma squared is also significant in implying that firms that operated in an inefficient manner, and budgeting of stochastic frontier production model is better than the average production model in analysing industrial production processes.

Table 4
Parameter estimation of stochastic frontier production model

Variable	Coefficient	t-ratio
Constants (B_0)	0.892	8.979***
LnCapital (B_1)	–0.048	–0.160
LnLabour (B_2)	–0.284	–0.613
0.5(LnK*LnK) (B_3)	0.215	3.429
0.5(LnL*LnL) (B_4)	0.488	3.473
LnK*LnL (B_5)	–0.239	–3.136
Sigma-square	0.399	4.699***
Gamma (γ)	0.322	2.054***
Log likelihood function	–116.416	
LR test of the one-sided error	50.001	

*, **, and *** significant at 10%, 5%, and 1% levels respectively

Based on Table 5, several variables of technical inefficiency are significant except for employee training expenses, the ratio of highly-qualified employees, the ratio of employees with secondary education, and the dummy firm's size. The negative sign indicates that an increase in the variable will decrease the technical inefficiency while the positive sign indicates otherwise. Wage rates play an important role with real coefficients of –0.779 and significant at 5% significance level. This shows that when employees' wages increase by 1 unit, the technical inefficiency will decrease at 0.008 points. Based on the statements of National Accounts Annual GDP (2005–2011) for the period of 2005 to 2010, there was an increase of 67.0% or RM1.2 billion of total salaries and wages paid to employees of transportation manufacturing industries in Malaysia. This shows an increase in wages to employees can motivate employees to improve their productivity and ultimately increase the amount of production output at an optimal level. In fact, the level of technical efficiency of a firm will also increase. These results support the studies by Yao and Zhang (2001), Muhlau and Lindenberg (2003), and Liew, Zulridah, and Tee (2012).

Besides that, ICT cost will also significantly influence output at 5% significance level. When ICT cost increased by 1 unit, the technical inefficiency will decrease by 0.036 points. These cost include services, hardware consultancy, software consultancy and supply, data processing services, and database activities as well as online communication or facsimile. According to Heshmati and Yang (2006), and Wu (2008), the contribution of ICT capital investment through productivity can also generate a significant positive result. The increase in these expenses has led to a reduction in engineering firm operating inefficiencies. In fact, Mahadevan and

Mansor (2007) posited that investment in ICT is extremely important to improve the efficiency and productivity of a firm.

Nonetheless, the ratio of capital-labour indicates an increase in technical inefficiency. The result shows that when the ratio of capital-labour increases by 1 unit, the inefficiency will increase by 0.7%. This result is inconsistent with those from past studies which claimed that the ratio of capital-labour has a positive relationship with the determinants of efficiency and inefficiency, such as in Nelson and Phelps (1966), Maudos, Pastor, and Serrano (1999), Jacobs, Nahuis, and Tang (2000), Stevens and Kneller (2003), and Amdun (2007). However, this study is consistent with the findings by Noor Aini, Basri, and Putri (2008) who found the capital-labour ratio is positively related with engineering firms inefficiency. Results obtained from this study are associated with excess capacity in the use of capital for the industrial manufacturing of transport. When there is an increase in the capital such as the improvement of technology and labour efficiency which is not timely upgraded, then there is the effect of increasing inefficiency engineering firm because employees need to adapt to new technology. According to the DOS, the capital-labour ratio experienced a negative growth of –4.0% in 2010.

Table 5
Determinants of technical inefficiency

Variable and parameter	Model SF	t-value
	Translog	
Constants (β_0)	1.183	1.683*
LnRatio of capital-labour (β_1)	0.721	3.759***
LnEmployee training expenses (β_2)	0.956	0.914
LnRatio of TIER (β_3)	–0.199	–1.377
LnRatio of SEC (β_4)	1.186	1.373
LnWages (β_5)	–0.779	–3.568***
LnCommunication expenses (β_6)	–3.633	–3.786***
Dummy firms size (β_7)	0.0185	0.067

*, **, and *** significant at 10%, 5%, and 1% levels respectively

CONCLUSION

This study aims to measure the level of efficiency and analyse the determinants of the technical inefficiency of transport manufacturing industry in Malaysia. The analysis was based on data gathered from the DOS comprises of 130 firms

involved in the overall six subsectors of transport manufacturing firms in Malaysia. The findings were obtained through hypotheses which indicate that the function of translog production being selected to investigate the efficiency level and determinants of firms' inefficiency. All in all, the level of technical efficiency of the transport manufacturing industry is still moderate, although 66% of the operating firms were above 0.50 of the efficiency range.

The following findings indicate that firms which belonged in third and fourth subsectors had the most participation in this study. The regression result reveals that determinants such as employees wage rates and the cost of ICT are significant in reducing firms inefficiency. Meanwhile, the ratio of capital-labour is found to have a negative relationship since the result shows its increase causes firm inefficiency. In conclusion, transport manufacturing firms in Malaysia should take initiatives to improve employees wage rates for the purposes of improving employees' productivity and motivation which will eventually increase the amount of production in the future. The increase in wage payment can be given based on employees' performance, experience, and occupational situation. Besides that, work factors such as duties, responsibilities, and work conditions should be taken into account when firms are considering to raise employees' wage rates.

Furthermore, firms need to spend on ICT to improve production that can result in transport manufacturing firms' efficiency. Employees with knowledge in ICT can improve their knowledge and skills besides strengthening the network of production market even at the local level. This is in line with the 11th Malaysia Plan in accelerating the industries growth based on knowledge in the enhancement of productivity through innovations to strengthen competitiveness and generate affluence.

The study, however, has a limitation. It is difficult to have access to firm's data. Most of the employers were reluctant to cooperate in answering the questionnaires submitted by the DOS. This has caused difficulties in obtaining extensive firm's data which is valuable for this study. Based on the limitations that have been encountered in this study's, the following are some recommendations for further research. First, increasing the number of existing firms to obtain the results of a more comprehensive technical competence. Second, additional variables that affect technical inefficiency can be investigated such as research and development, exports and imports. Third, a further research to identify and compare the results of using two different approaches in modelling the SFA and DEA (data envelopment analysis). The comparisons of the results can indicate whether there are differences or similarities in the obtained results.

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